

**Oroville Facilities Relicensing Efforts  
Environmental Work Group  
Draft Narrative Reports for Resource Action Discussion**

**Resource Action: EWG-15A/B**

**Task Force Recommendation Category: 2**

**CHINOOK SALMON SPAWNING SEASON FLOW INCREASES TO REDUCE  
CHINOOK SALMON REDD SUPERIMPOSITION**

**Date of Field Evaluation:** None, reformatting of previously delivered document

**Evaluation Team:** Allison Niggemyer, David Olson

**Description of Potential Resource Action Measure:**

Description of EWG-15A - Incrementally increase flows in the low flow channel from relatively low flows (for example, 400-600 cubic feet per second (cfs) or 600-800 cfs) to relatively high flows (for example, 800-1000 cfs or 1000-1200 cfs) throughout the Chinook salmon spawning season (for example, Sept 1 – Dec 1 or Sept 1 - Dec 15) in order change the lateral spawning habitat distribution from center of river channel during the early portion of the spawning season to margins of river channel in the later portion of the spawning season. Flows would be increased by some relatively consistent interval each week (for example, 25, 50, or 75 cfs/week) in order to increase usable spawning habitat and reduce superimposition of Chinook salmon redds. Once flows reach the high flow target, the high flow target would be maintained through May 30 in order to avoid dewatering Chinook salmon and steelhead redds through the incubation period for both species.

Description of EWG-15B - Increase flows in the low flow channel from relatively low flows (for example, 400-600 cfs or 600-800 cfs) during the early season spawning period to relatively high flows (for example, 800-1000 cfs or 1000-1200 cfs) for the period of the Chinook salmon spawning season after spring-run Chinook salmon are believed to have completed spawning. This flow change would be designed to be more beneficial to the early spawners (spring-run?) in order change the lateral spawning habitat distribution from center of river channel during the early portion of the spawning season to margins of river channel in the later portion of the spawning season. Flows would be increased one time in the spawning season. Once flows reach the high flow target, the high flow target would be maintained through May 30 in order to avoid dewatering Chinook salmon and steelhead redds through the incubation

**Nexus to the Project:**

The Oroville project influences flow regimes in the lower Feather River and controls releases that determine the quantity and quality of suitable salmonid spawning habitat.

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**Potential Environmental Benefits:**

- Increased quantity of Chinook salmon spawning habitat;
- Increased quality of Chinook salmon spawning habitat;
- Reduced redd superimposition of Chinook salmon redds (EWB-15B would be more beneficial to early season spawners); and
- Decreased Chinook salmon egg mortality (EWB-15B would be more beneficial to early season spawners).

**Potential Constraints:**

Early spawning season flow releases would need to be sufficient to provide an adequate amount of suitable spawning area to support early season spawners and well as provide for suitable water temperatures for spawning. High flow targets to achieve lateral distribution changes in spawning habitat distributions may require substantial releases of water that may adversely affect water supply and power generation. The sustained high flows at the end of Chinook spawning could potentially adversely affect steelhead spawning and juvenile salmonid rearing habitat quality and quantity.

**Recreation Issues (Mike – Butte County)**

**Existing Conditions in the Proposed Resource Action Implementation Area:**

The low flow channel is heavily utilized by spawning adult Chinook salmon. Of the Chinook salmon spawning that occurs between the Fish Barrier Dam and Honcut Creek, approximately one-third occurs in the High Flow Channel, while approximately two-thirds occur in the Low Flow Channel. (DWR, Initial Information Package for Oroville Facilities Relicensing – P-2100) The intensive utilization of spawning habitat in the Low Flow Channel by adult Chinook salmon spawners results in redd superimposition, and is sufficiently intensive to prevent identification of individual redds in much of this reach of the Feather River. Historical study results suggest that superimposition reduces egg survival. Egg survival is thought to be reduced in the Low Flow Channel as a result of redd superimposition.

A superimposition index was calculated for the low flow channel and high flow channel in 1995. In 1995, CDFG estimated the number of adult Chinook salmon spawners in the low flow channel at 44,111 and in the high flow channel at 15,572. In 1995, the total spawning area was estimated in the low flow channel was estimated at 773,732 square feet and in the high flow channel, the total spawning area was estimated at 915,289 square feet. Using Bell's estimate of 55 square feet for the surface area of an average sized Chinook salmon redd, the superimposition index can be calculated using the following formula:  $\text{superimposition index} = [(\text{escapement} * 0.5) * 55\text{ft}^2] / \text{total spawning area}$ . For 1995, the calculated superimposition index was 1.57 in the low flow channel and 0.47 in the high flow channel. As a result, the focus of this proposed resource action is to increase the quantity of spawning habitat by altering later spawning habitat distribution in the low flow channel only.

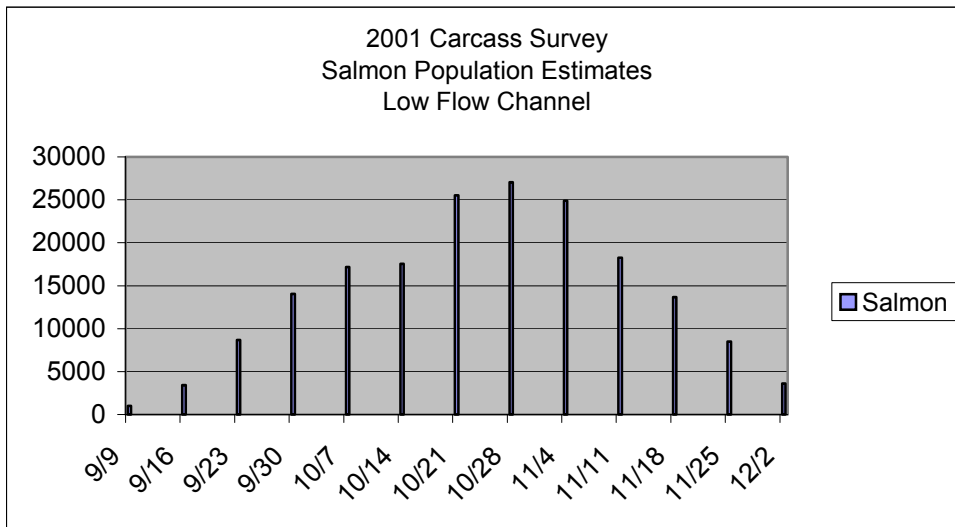
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Chinook salmon spawning occurs in the Low Flow Channel from September – December, see Figure 1 below. The graph shows the temporal distribution of spawning from DWR's ongoing annual carcass survey. The number of spawning Chinook salmon is not evenly temporally distributed, with peak spawning activity occurring in approximately mid-October through mid-November.

Figure 1: 2001 Carcass Survey Salmon Population Estimates - Low Flow Channel



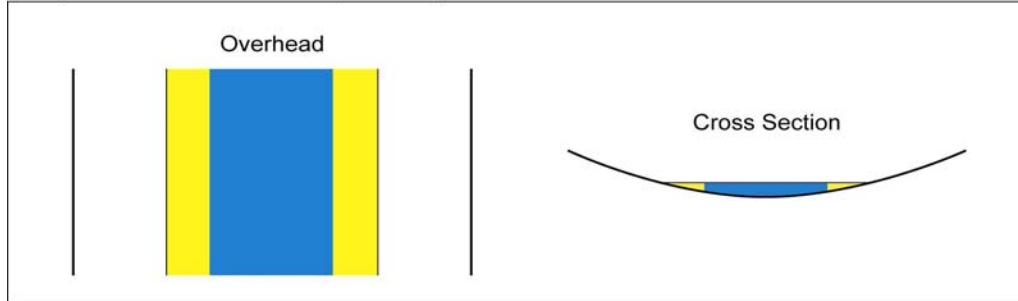
**Design Considerations and Evaluation:**

Description of EWG-15A - Low flows (for example, 400-600 cfs or 600-800 cfs) during early part of the spawning season would require early Chinook salmon spawners to utilize the center portion of the river for spawning habitat. Increasing flows (for example, to 800-1000 cfs or 1000-1200 cfs) incrementally over the spawning season by some relatively consistent interval each week (for example, by 25, 50, or 75 cfs/week) in the later portions of the spawning season would encourage later spawners to utilize suitable spawning habitat on the margins of the river. Altering the location of the margin of the river within the river channel over the course of the spawning season may alter the lateral distribution of spawning over the season, resulting in decreased redd superimposition.

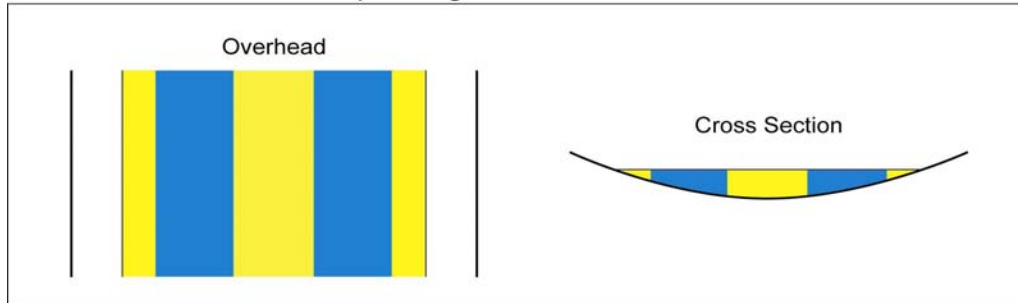
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Figure 2: Conceptual Representation of Spawning Habitat  
Conceptual Representation of Spawning  
Habitat Lateral Distribution

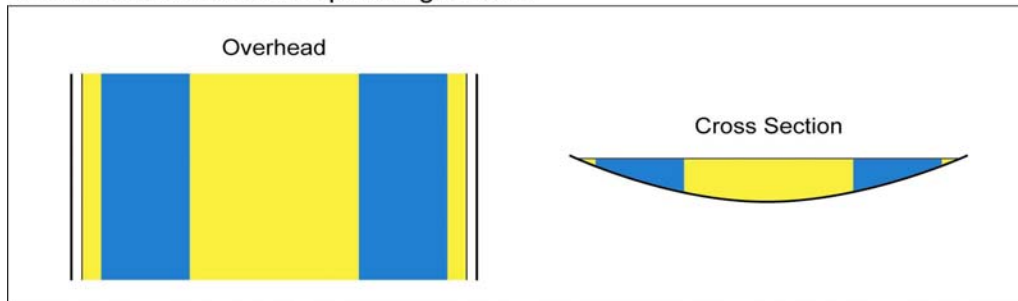
Early in Chinook salmon spawning season



Middle in Chinook salmon spawning season



Late in Chinook salmon spawning season



Suitable Depth and Velocity



Unsuitable Spawning Habitat

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Any proposed flow regime that manipulates the amount of spawning habitat should take into account the number and temporal distribution of Chinook salmon spawners and the amount of habitat required for spawning at any given time throughout the spawning season. The peak of spawning activity in the Low Flow Channel occurs in approximately mid-October through mid-November and represents the portion of the spawning season with the highest amount of competition for spawning habitat. The proposed flow regime should incorporate the objective to provide the maximum amount of suitable habitat at the peak of spawning activity.

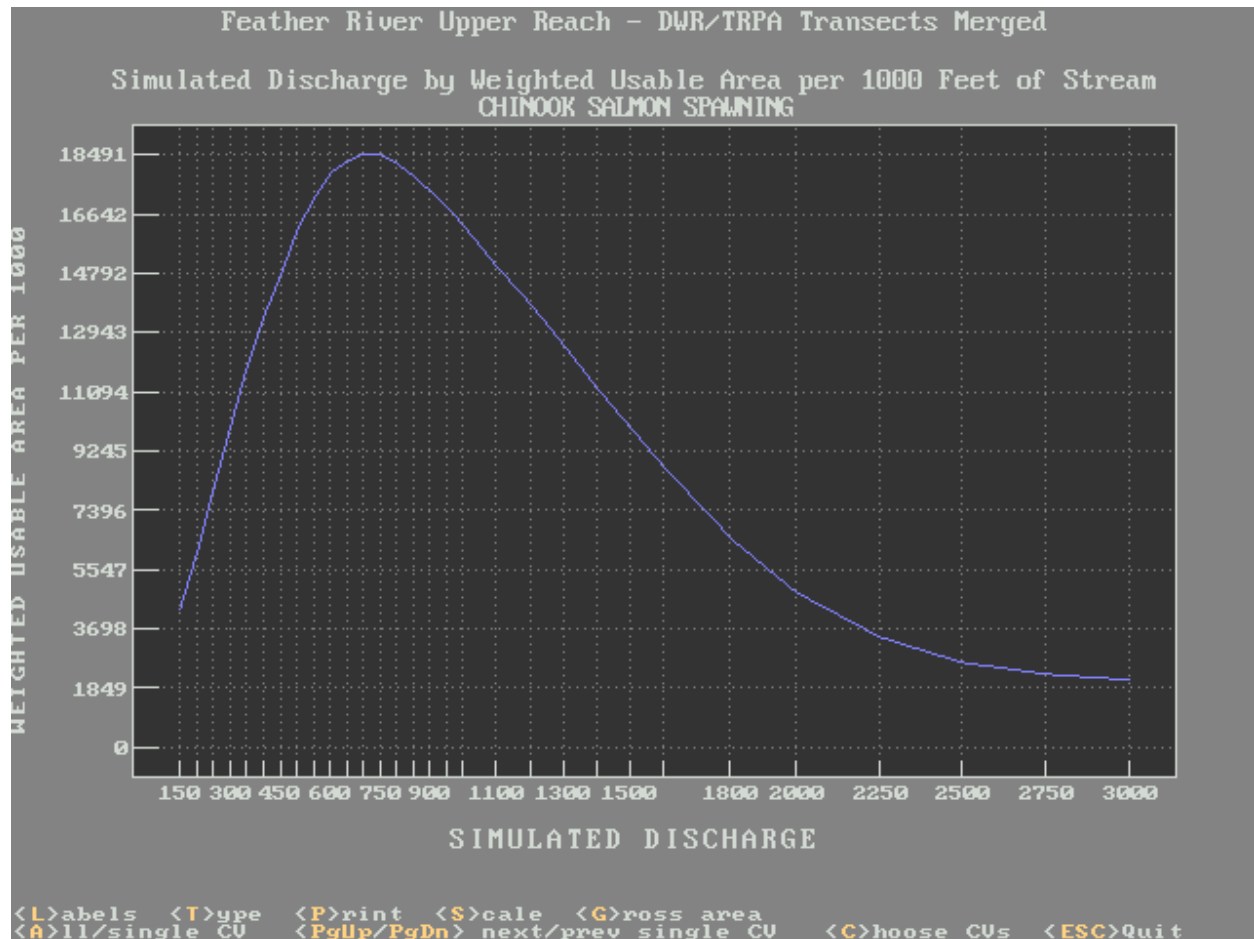
The PHABSIM (physical habitat simulation) model produced as part of Phase 2 of Study Plan, SP-F16 is an appropriate tool to evaluate some of the essential questions regarding whether the proposed flow prescription will likely result in successful manipulation of the lateral distribution of spawning habitat in the low flow channel. These questions include: 1) would low flow targets provide adequate spawning habitat for early spawners; 2) how much spawning habitat would be created (and lost due to water velocity spawning habitat constraints) for each increment of flow increase; 3) how much total spawning habitat would be created by implementing the proposed flow regime; 4) would the proposed flow manipulation result in changes to the lateral distribution of spawning habitat; and 5) if PHABSIM output is used to estimate the changes in lateral spawning distribution as a result of the proposed flow changes, do calculations of the redd superimposition index using the model output suggest that the proposed change in flows would reduce overall superimposition of Chinook salmon redds?

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Figure 3: Preliminary SP-F16 Phase 2 Results - Low Flow Channel Chinook Salmon Spawning Weighted Usable Area Index



Although the specific analyses of the PHABSIM output on the response of Chinook salmon spawning habitat lateral distribution have not been conducted, the preliminary draft of the Chinook salmon spawning habitat weighted usable area are available, see Figure 3 above.

The range of appropriate low and high flows for developing this flow prescription should also take into account the projected quantity and quality of resulting spawning habitat at those flows. The PHABSIM output should be able to aid in determining logical low flow targets for consideration in this flow prescription by illustrating the habitat availability over a range of flows. The PHABSIM provides an index of the amount of available habitat. An analysis of the actual amount of habitat required to support the early season spawners as well as consideration of potential temperature impacts of low flows early in the spawning season, would need to be evaluated before a definitive flow target could be recommended. The model also could provide velocity information for higher flows to determine the upper range of velocities to consider. This upper range should not be so high that it would scour spawning riffles, yet should be high enough to result in less

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favorable conditions for Chinook salmon spawning in the middle of the channel, where redds were constructed during lower flows. Spawning depth and lateral redd distribution could be monitored as part of the adaptive management program to determine the success of manipulating the lateral distribution of spawning habitat and fish behavioral responses to the conditions created.

Another design consideration would be the potential effect of the late spawning season/sustained flow targets on the quality and quantity of steelhead spawning habitat. As demonstrated by the Chinook salmon spawning WUA graph in Figure 3, the amount of habitat can be reduced at higher flows. Any flow recommendation for this Resource Action would also need to evaluate if the prescribed flows provided an adequate amount of steelhead spawning habitat. A WUA for steelhead is not currently available and it has not been investigated yet if one could be generated from existing information (there may not be an adequate number of steelhead spawning observations available). The number of steelhead spawners in the Feather River is not currently known or documented. Relicensing study plan results are not expected to provide quantitative documentation of the number of steelhead spawners.

Other critical evaluation components for the development of the flow prescription include: modeling temperature impacts of flows below current flow regime on downstream water temperatures during the early portion of the Chinook salmon spawning season. The ability to comply with the water temperature requirement of 65°F at Robinson Riffle may be affected if flows lower than 600 cfs are chosen as the low flow requirement early in the spawning season. This potential impact could be modeled by the E&O water temperature model (WQRRS). If lower flows would result in difficulty complying with the Robinson Riffle water temperature requirement, this could potentially be resolved by utilizing colder water releases from Lake Oroville. Hatchery water temperature constraints may limit the ability to use colder water from Oroville reservoir as September 1 – 30 water temperatures may currently be no colder than 48°F and October 1 – November 30 water temperatures are required to be no colder than 47°F per the DFG 1983 operating agreement. If the hatchery water temperature requirements constrain the ability to achieve water temperature compliance requirements at Robinson Riffle at lower flows during the early portion of the Chinook salmon spawning season, the hatchery could potentially be provided with a separate water supply. A separate hatchery water supply proposed Resource Action would require its own set of investigations.

EWG-15A Comparison to EWG-15B Design Considerations - Evaluating the EWG-15A proposed Resource Action will require comparison against EWG-15B, a PM&E with a similar mechanism and framework, but slightly different overall resource goals. EWG-15B suggests providing a low flow for the first part of the Chinook salmon season and maintaining that low flow until spring-run Chinook salmon spawning is believed to be complete. Then, flows would be increased to the target high flow range. While EWG-15A also utilizes flow increase to alter the lateral distribution of spawning, it suggests weekly incremental flow increases throughout the Chinook salmon spawning season in

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order to achieve the same high flow target as EWG-15B by the end of the spawning season.

The strategy proposed in EWG-15B is simpler operationally, but relies upon a higher degree of confidence regarding the temporal distribution of the spring-run Chinook salmon spawners, which may be variable from year to year. Additionally, EWG-15B is designed specifically to benefit spring-run Chinook salmon to the extent possible. The strategy proposed in EWG-15A would be slightly more operationally complex to execute, but would reduce potential water temperature compliance issues and would not be susceptible to the variability in run timing. However, EWG-15A is designed to benefit all Chinook salmon spawners equally from the change in lateral spawning distribution, including those Chinook salmon spawning at the middle and end of the spawning period. Any proposed flow prescription designed to achieve this resource objective should be treated as an adaptive management program that would be managed and improved based on monitoring and continued evaluations.

**Synergisms and Conflicts:**

Sustained high flows through May could potentially benefit programs for increased flows or pulsed attraction flows during this part of the year. Species that could potentially benefit from these increased flows could include Sacramento splittail, sturgeon and spring-run Chinook.

Potential conflicts may include adverse impacts to the quantity and quality of steelhead spawning and salmonid rearing habitat. Additionally, meeting temperature control requirements at Robinson Riffle may not be possible in reduced early season spawning flows. The sustained high flows will cause power generation opportunity costs.

**Uncertainties:**

- Probably the greatest uncertainty with this measure is in the ability to manipulate flows to a degree that consistently accomplishes the desired biological response in the fish's preferences for spawning habitat sufficient to achieve movement in the lateral distribution of suitable spawning in the channel.
- Biological response of the fish may be based on a combination of factors in which flows, depths and velocities manipulated in these flow prescriptions are only a part of their basis. Water year type, year class strength and condition factors along with other factors not yet identified will likely require the flow management prescriptions and timing for the program to be adaptive based on annual conditions and monitoring program feedback.
- EWG-15B's program management and success are more susceptible to interannual variations in the temporal distribution of the runs.

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**Cost Estimate:**

If the proposed action were to be evaluated for flows of 400 cfs ramping to a 1000 cfs flow from September 1 – May 30 (protective of steelhead incubation), this action would require a net increase of approximately 160,000 acre feet released through the low flow channel over the current flow regime which would have an annual power generation opportunity cost of approximately \$450,000 based on average power production assumptions.

**Recommendations:**

This proposed Resource Action may improve the potential impacts from (although not quantified in its severity or relative importance to the species' success) superimposition of Chinook salmon redds associated with intensive utilization of spawning habitat in the low flow channel. Further information detailing the likely response of adult spawners to flow changes (primarily from SP-F16) would be needed to aid in determining the low and high flow targets before a definitive flow management prescription could be developed. An adaptive management approach to any flow prescription is recommended in combination with a redd distribution monitoring program to characterize the fish spawning habitat utilization in response to flow changes.

If this Resource Action is to be further developed, additional information anticipated that would be required to develop a recommended flow prescription for an adaptive management program would include: 1) Aerial extent of total spawning area delineated from aerial photographs - SP-G2, 2) WUA: for spawning Chinook salmon (and steelhead?) - SP-F16: October 2003; 3) redd superimposition index calculation - SP-F10 Task 2B: Jan 2004, 4) carcass survey data: SP-F10 Task 2B: final report Jan 2004.

The Fisheries Task Force recommendation - Category 2 Waiting (SP-F16 PHABSIM model results)